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ABSTRACT

Twelve learning disabled (LD), 12 learning disabled hyperactive (LDH) and 12 hyperactive (H) boys (6-11 years old) participated in an investigation of selective attention. Ss were asked to search for a target letter embedded within an array of noise letters. Two variations were included: one involving a simultaneous search for four possible target letters, the other involving a physical dissimilarity between the target and noise letters. Results indicated that latencies of the LD and LDH Ss were significantly longer than those of control Ss. The latencies of the H Ss were not longer than those of control Ss. Results supported Ross's suggestion that a deficit in selective attention is characteristic of LD Ss but not H Ss. (Author/CL)

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Visual Search in Learning Disabled and Hyperactive Boys

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Running Head: Visual Search

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Abstract

Ross (1976) has suggested that a deficit in selective attention is characteristic of learning disabled children but not hyperactive children. In the present study, this suggestion was tested using a visual search paradigm which required learning disabled, learning disabled-hyperactive, hyperactive and normal control boys to search for a target letter embedded within an array of noise letters. Two variations of this basic paradigm were included: one involving a simultaneous search for four possible target letters; the other involving a physical dissimilarity between the target and noise letters. The time required for the subject to find the target letter was the dependent variable. Results indicated the latencies of the learning disabled and learning disabled-hyperactive boys were significantly longer than those of their controls; the latencies of the hyperactive boys were not longer than those of their controls. Thus, Ross' suggestion was supported.

Visual Search in Learning Disabled and Hyperactive Boys

Specific learning disabilities have received a great deal of interest in recent years. Much of this interest has been generated by an increasing awareness of their incidence; they are estimated to affect up to 15% of school children (Lerner, 1971). Of the many symptoms associated with learning disabilities, a deficit in attention seems to be the most damaging for school performance. After a thorough review of the literature, Ross (1976) suggested that a deficit in selective attention, i.e., in focusing attention exclusively on relevant information, is characteristic of learning disabled children. In addition, he suggested this deficit is not characteristic of hyperactive children.

In the present study, Ross' suggestions were tested by comparing selective attention in learning disabled, learning disabled-hyperactive, hyperactive, and normal children. Selective attention was assessed by means of a visual search paradigm originally developed by Neisser (1963). Basically, this paradigm requires the subject to search for a target letter which is embedded within an array of noise letters. The time required for the subject to find the target letter was the dependent variable. Three separate search conditions were included; all involved a basic manipulation of the physical location of the target letter within the stimulus array. One condition involved the subject searching for a single target letter within each stimulus array - the Single Target search condition; a second involved the subject searching simultaneously for any one of

four possible target letters within each stimulus array - the Multiple Target search condition; a third involved the subject searching for a single target letter within stimulus arrays containing only noise letters which were physically very dissimilar from the target letter - the Dissimilar Noise search condition.

Method

Subjects[1]

Seventy-two boys served as subjects: twelve were learning disabled only (LD), twelve were both learning disabled and hyperactive (LDH), and twelve were hyperactive only (H). The other thirty-six were normal controls matched with the LD, LDH, and H boys on age, IQ, and socioeconomic status. This yielded three matched control groups, each consisting of twelve boys (CLD, CLDH, and CH).

The ages of the boys ranged from 6 years, six months to eleven years, eleven months, with a mean age of eight years, six months, for the LD and CLD boys; a mean age of eight years, ten months, for the LDH and CLDH boys; and a mean age of eight years, seven months, for the H and CH boys.

The diagnoses of learning disability were based upon a complete psychoeducational evaluation performed by a diagnostic team including a psychometrist, a social worker, a clinical psychologist, and a pediatric neurologist. Each child in the LD and LDH groups demonstrated specific deficits in the basic processes necessary for the acquisition of secondary language/symbol skills (Murray, 1978). Academic achievement in reading and spelling were not commensurate with demonstrated intellectual functioning.

Intelligence test scores were in the normal range for both the LD and LDH groups (mean scores are presented in Table 1).

Insert Table 1 about here

The diagnoses of hyperactivity were made concurrently by a pediatric neurologist and a clinical psychologist based upon medical and developmental histories, behavioral observations, teacher's reports, and a score significantly above the mean on the Conner's Scale of Hyperactivity.

All the subjects were normal in intelligence, ranging in IQ from 85 to 120, and were from middle class backgrounds. None evidenced either brain damage or primary emotional disturbance.[2]

Apparatus

The basic apparatus consisted of a slide projector, projection screen, foot pedal, and timer. A rear-projection screen (one foot by one foot) was used with the subject seated at a comfortable distance (about 18 inches). The foot pedal was depressed by the subject to initiate a trial and to start the timer. The subject held the foot pedal down until the target letter was found, then released the pedal, stopping the timer, extinguishing the stimulus array, and replacing it with a grid slide. The grid slide contained five equal horizontal areas, each corresponding to one fifth of the stimulus array.

Each stimulus array consisted of 25 rows, with each row containing six capital block letters (IBM Selectric Orator 12 type). A target letter was located in either row 5, 9, 13, 17, or 21 of each stimulus array (each of these rows was located in a separate fifth of the stimulus array and grid slide). For each of the Single Target and Dissimilar Noise stimulus arrays, the target letter, K, was used. For the Multiple Target stimulus arrays, the target letter used for each array was randomly selected from a set of four possible target letters, K, M, O, or Z. Only one of these four target letters was included in each Multiple Target stimulus array. Since the subject did not know which target letter was included in the array he had to search for all four target letters simultaneously on each trial. The target letters (or letter) to be searched for on any given trial were displayed on a card located above the stimulus array. The noise letters used also varied with the search condition: For the Single Target and Multiple Target stimulus arrays, the background letters used were randomly selected from a pool of 18 letters (K, M, N, O, Q, X, Y, and Z were not used). For the Dissimilar Noise stimulus arrays, the background letters used were randomly selected from a pool of four circular letters (C, G, D and U).

Design and Procedure

Each trial consisted of a set of two slides; a stimulus array slide followed by a grid slide. The subject was asked to find the target letter on the stimulus array slide, to point to it (thus designating the corresponding area when the grid slide appeared), and to release the foot pedal. The pointing response allowed E to check for detection errors.[3]

Four blocks of five trials each were presented. The first block of five practice trials contained only Single Target search condition trials. These trials were given first to insure that the subjects understood the task, procedures, and instructions.[4] The remaining three blocks of experimental trials were randomly ordered and consisted of one block each containing either Single Target, Multiple Target, or Dissimilar Noise search condition trials. Hence, a total of 20 trials were given; 5 practice trials and 15 experimental trials (five corresponding to each of the three search conditions).

Results and Discussion

The basic data were the latencies to detection of the target letter. A 6 (groups) x 3 (conditions) x 5 (rows) analysis of variance applied to the logarithmic transformations of these latencies revealed significant main effects for groups ($F=3.15$, $df=5/66$, $p < .02$); for conditions ($F=237.49$, $df=2/132$, $p < .01$); for rows ($F=8.52$, $df=4/264$, $p < .01$); and for the conditions x rows interaction ($F=3.75$, $df=8/528$, $p < .01$).

Planned contrasts (a priori F's) applied to the latencies of the learning disabled, learning disabled-hyperactive, and hyperactive groups and their respective control groups revealed the latencies of the learning disabled and the learning disabled-hyperactive groups were significantly longer than those of their control groups ($F=7.94$, $df=1/66$, $p < .01$; and $F=4.99$, $df=1/66$, $p < .03$; respectively). The mean latency of the hyperactive group did not differ significantly from that of their controls. (See Table 2.) This pattern of results supports Ross' (1976) suggestion that a deficit in selective attention is characteristic of learning disabled children but not of hyperactive children.

Newman-Keuls multiple comparison tests ($p < .01$) revealed the mean latency for the Dissimilar Noise search condition was significantly shorter than the mean latency for the Single Target search condition which, in turn, was significantly shorter than the mean latency for the Multiple Target search condition. (See Table 2.) This pattern of

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Insert Table 2 about here

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results was expected; previous research (see Neisser, 1967) using normal adult subjects had yielded similar results.

Clearly, all the subjects were able to make use of the physical dissimilarity existing between the angular target letter (K) and the circular noise letters (C, D, G, and U) used under the Dissimilar Noise search condition. Moreover, they were able to use this difference to decrease their visual search times below those obtained for the Single Target search condition where the randomly selected noise letters varied in their physical dissimilarity from the target letter. Equally as clearly, none of the subjects were able to search for four target letters simultaneously (as required under the Multiple Target search condition) as quickly as they were able to search for a single target letter (as required under the Single Target search condition). Evidently, a substantial amount of practice would be required before any of the subject groups would be able to search for several target letters simultaneously as efficiently as they search for one.

The failure to find a significant groups x conditions interaction indicates all the groups of boys performed similarly under all three search conditions. Moreover, it indicates that the differences observed between the learning disabled and learning disabled-hyperactive boys and their respective control groups were constant across all three search conditions.[5]

Additional Newman-Keuls multiple comparison tests ($p < .05$) revealed the mean latency obtained when the target was in row 5 of the stimulus array was significantly shorter than those obtained when the target was in Rows 9 or 13 which, in turn, were significantly shorter than those obtained when the target was in rows 17 or 21. Application of a trend analysis to these means revealed a significant linear trend ($F=3.90$, $df=1/264$, $p < .05$). As can be seen in Table 3, this pattern of results

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Insert Table 3 about here

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indicates the subjects used a fairly straight forward pattern of visual search, i.e., after entering the stimulus array, they usually proceeded from top to bottom.

Inspection of the conditions x rows interaction matrix presented in Table 3 reveals a tendency for the mean latencies to increase with rows (going from top to bottom) for the Single Target and Dissimilar Noise conditions but not for the Multiple Target search condition. Subsequent

trend analyses confirmed this pattern: significant linear trends were found for the Single Target search condition ($F=4.52$, $df=1/264$, $p< .01$) and the Dissimilar Noise search condition ($F=18.34$, $df=1/264$, $p< .01$); a significant quadratic trend was found for the Multiple Target condition ($F=7.47$, $df=1/264$, $p< .01$). Evidently, a fairly straightforward pattern of visual search was used for the Single Target and Dissimilar Noise search conditions, i.e., after entering the stimulus array at some point the search usually proceeded from top to bottom. Under the Multiple Target search condition, however, the pattern of visual search was less clear. Perhaps, after entering the stimulus array each of the four possible target letters may have been searched for sequentially rather than simultaneously. This seems likely given the increased memory demands of this search condition (the boys may have found it more difficult to keep four target letters in mind simultaneously). In addition, it is possible that the search for a specific target letter may have been abandoned before the entire stimulus array was searched (especially if the boys could not keep all four target letters in mind and had to glance at the reminder card displaying them). If this was the case, then some parts of the stimulus array may have been searched several times for different target letters while other parts were not. This may have resulted in the non-linear pattern observed for the Multiple Target search latencies.

In terms of the information processing models usually associated with the visual search paradigm, the difference in latencies between the Single Target and Dissimilar Noise search conditions indicates the search processors of all the boys were able to use target-noise dissimilarity to eliminate very dissimilar letters early in the test hierarchy while allowing more similar letters to pass on to be tested again at later stages. In other words, their search processors were capable of making several analyses concurrently and did not have to devote an equal amount of analytic power to each letter to decide if it was target or noise. In addition, the difference in latencies between the Single Target and Multiple Target search conditions indicates the search processors of these boys were not able to search for more than one target letter simultaneously. Evidently, additional practice would be required before they could search for several targets simultaneously. Interpretations similar to these have been suggested in the adult visual search literature (See Neisser, 1967).

In closing, two suggestions, one diagnostic and one remediational, can be derived from the present study. First, a diagnostic visual search task might be developed which would involve recording the time necessary for the child to find and circle a target letter among an array of letters on a printed page. Given appropriate norms, this could be used to determine the severity of the attentional deficits of individual learning disabled children. Second, procedures for remediation might involve demonstrating attentional strategies appropriate to a visual search task (e.g., following

a visual marker which moves progressively from the top to the bottom of the stimulus array). However, additional research directed towards differentiating the attentional deficits characteristic of different types of learning disabled boys and identifying appropriate remediational strategies is needed. At present, our understanding of problems in selective attention and the best techniques for their remediation is quite limited.

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Footnotes

[1]The authors thank the staff, teachers, and students of Dean Memorial Learning Center, Scottish Rite Memorial Hospital, and Greenhill School, all in Dallas, Texas, for their kind help and cooperation.

[2]Four learning disabled boys, four learning disabled-hyperactive boys, and all the hyperactive boys were taking therapeutic drugs; most were taking Ritalin while one learning disabled hyperactive boy was taking Tofranil. All the subjects taking drugs were given a drug holiday for three days before participation in the present experiment. Comparison of the results obtained for the boys receiving therapeutic drugs with those who were not failed to reveal any significant differences.

[3]Detection errors were negligible (occurring with a frequency of less than 1%). When an error occurred, the trial was repeated later without the subject's awareness and the latency from the second trial was used in the analyses.

[4]An analysis of variance used to contrast the subjects' performances on the practice and experimental Single Target search condition trial blocks failed to reveal a significant main effect for blocks or for any of its interactions. Moreover, using data from either of these blocks did not change the pattern of results found in the analyses of variance used to contrast the Single Target, Multiple Target, and Dissimilar Noise search conditions. Evidently, the limited additional exposure given the Single Target search condition did not confound the results of the experiment.

[5]This pattern of results was confirmed in separate analyses of variance used to contrast each of the disability groups with its respective control group.

Table 1

Intellectual Profile of the LD and LDH Subjects

	Groups							
	LD				LDH			
Source	N	$\bar{X}$	SD	SE	N	$\bar{X}$	SD	SE
WISC-R (Full Scale IQ)	12	98.92	7.75	2.24	12	99.00	5.75	1.66
WISC-R (Verbal IQ)	12	100.42	9.88	2.86	12	103.25	7.85	2.27
WISC-R (Performance IQ)	12	97.83	9.41	2.72	12	94.83	8.02	2.32

Table 2

Mean Latencies

(in secs)

	Groups						
	LD	CLD	LDH	CLDH	H	CH	Mean
Search Conditions							
Single Target	36.94	21.12	23.76	19.43	31.50	25.67	26.40
Dissimilar Noise	14.66	9.19	13.58	7.70	11.53	10.70	11.23
Multiple Target	45.03	35.59	47.75	33.83	49.20	40.54	41.99
Mean	32.21	21.96	28.36	20.32	30.74	25.64	26.54

Table 3

The Conditions x Rows Interaction

(Mean Latencies in secs)

Target Location	Search Conditions: Single Target	Dissimilar Noise	Multiple Target	Mean
Row				
5	19.96	7.79	44.76	24.17
9	30.75	9.98	35.10	25.28
13	20.46	10.96	37.04	22.82
17	31.30	12.10	42.44	28.61
21	29.55	15.30	50.62	31.83
Mean	26.40	11.23	41.99	26.54